

Habitat loss and species loss: the birds of Sydney 50 years ago and now

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ABSTRACT

Over the last 50 years major areas of bird habitat have been lost from the County of Cumberland. Included are the major saltmarshes and freshwater swamps from the western side of Botany Bay; the tall forests of the Upper North Shore; and the woodlands of the Cumberland Plain between Parramatta and the Nepean. With this, major components of the former Sydney avifauna have become rare and at least eight species have been eliminated from the County as breeding species. Analyses are made of the avifaunas of these habitats as they existed in the 1930s and 1940s. It is confirmed that immediately a habitat goes so does the species dependent on it. Only one-third of the 108 forest and woodland species discussed occur in multiple habitats and hence are well insulated against change. The use of progressively degraded habitats is explored and it is found that only a very few species can persist once the process starts.

It is strongly argued that the key to understanding ecosystems and the biology and ecology of species is research: only when we understand how they operate, and their needs, can we minimize the impact and predict the impact of changes.

An extensive segment of the article is devoted to painting a word picture of habitats, familiar to the writer in the 1930s and 1940s, that are now extinct.

INTRODUCTION

This report had its origins in a breakfast discussion at the International Herpetological Congress in Adelaide in January 1994. I had outlined changes in the Sydney avifauna since my initial contacts with it in the 1930s. Your editor suggested I commit data to paper. A few weeks later I attended the Annual Meeting of the Australian Bird Study Association at Macquarie University. The topic of guest lecturer Jocelyn Howell, Royal Botanic Gardens and co-author of the book "Taken for Granted" (Benson and Howell 1990a) and the predecessor (Benson and Howell 1990b) was the massive change to the vegetation of the County of Cumberland* since European settlement. Of some eight original vegetation formations, two-thirds had either been lost or reduced to an insignificant fraction of their original area. There could not have been a more depressing message. But almost immediately, fascinating questions posed themselves to me: what had been the bird inhabitants of the lost formations; was the loss of birds the direct result of this; had some species been linked to specific habitats and could now only occur in small numbers in inferior secondary ones? I acknowledged that we do not know the precise biological or habitat needs of any of our bird species. Furthermore, bird usage data had never been

gathered for some of the Benson and Howell vegetation divisions. But why not accept your editor's invitation and develop my own data within a vegetation formation-habitat framework?

The afternoon lecturer was Alan Morris from the NSW National Parks and Wildlife Service: he documented many cases of species increase in later years, particularly in parrots and cuckoos. This is the "flip side" of the bird population story. Since the reasons for these cases of population increase are fairly obvious I will treat them only briefly here.

In the evening the group reconvened for a barbecue at a home in Turrumurra. The upper reaches of the Lane Cove River National Park lay only a few yards away. The Upper North Shore from Wahroonga to Thornleigh (Fig. 1) had been one of my main boyhood stamping grounds. I spent much of the evening handling questions about the past avifauna, and extracting data from the others on current occurrences. The need for writing this article was confirmed.

BACKGROUND AND RATIONALE

The data is developed as three interrelated manuscripts. The present paper documents the avifauna of the County of Cumberland of fifty years ago relative to today, focusing on

*"County" in Australia has no significance except as a land title unit. The County of Cumberland is, in effect, the region about 50 km around Sydney.

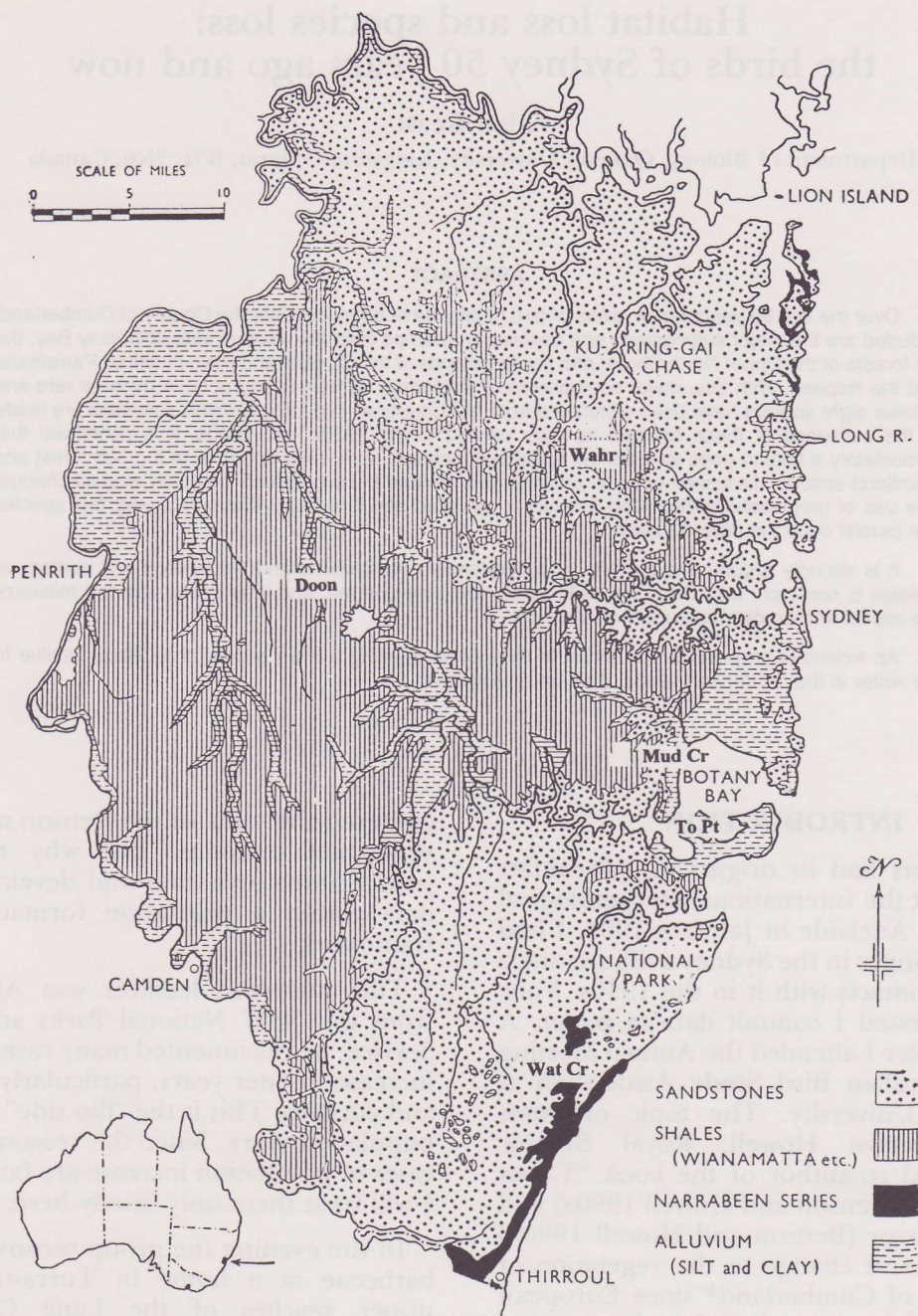


Fig. 1. The County of Cumberland, being the region around the City of Sydney in New South Wales. It is bounded on the west and north by a river called the Nepean near Camden and Penrith, and the Hawkesbury in the eastward-flowing part towards Lion Island. The City is centred around Sydney Harbour. As may be seen, the region is a geological basin with its centre near the middle of the map. As discussed in the text, the four major habitat associations reflect the underlying geology. The map is taken from Hindwood and McGill (1958); for a detailed vegetation map see Benson and Howell (1990). Abbreviations on the map are: To Pt = Towra Point; Mud Cr = Muddy Creek, representing the saltmarsh and freshwater swamp of Cooks River and Botany Bay; Wahr = Wahroonga, representing the tall eucalypt forest of the Upper North Shore; Doon = Doonside, representing the woodlands of the Cumberland Plain west of Sydney; Wat Cr = Waterfall Creek, representing the temperate rainforest of Royal National Park. There are a large number of detailed locations mentioned in the text; a Sydney street directory would be necessary to find all of them. As discussed in the text, the vegetation and birdlife have been much altered in recent times. Occupied by only a small number of Aboriginal hunter-gatherers when Captain Cook landed in Botany Bay in 1770, the population of the region now exceeds 3 000 000.

four significant regions and habitats. A discussion on how birds respond to habitat change and on conservation issues is incorporated. The second paper reviews the activities of the Sydney ornithological fraternity in the 1930–1950 period, which were largely centred around the monthly meetings of the Ornithological Section of the Royal Zoological Society. Many of Australia's then leading ornithologists were members of this group and the period was characterized by outstanding work. A third paper summarizes the unpublished data of Arnold McGill on six common migratory waders on the Botany Bay mudflats between 1942 and 1964. The area has now largely been lost to airport and ship-container port development.

This report has its origins in an unusual background: from 1931–1936 I was a child egg-collector, from 1939–1942 photographing birds at the nest in black-and-white, and from 1950 onwards a colour photographer. Developing a skill for nest-finding and the acquisition of the database on nesting seasons, and appreciation of breeding habitat specialization in birds, began early. They are interests that I have never lost.

As children we were only interested in one egg of each species but as we sought the nests of less common species we found increasing numbers of nests of common ones. Anybody who has worked for a period in an area soon learns that members of a species commonly nest in the same site, or chose one of similar configuration, from year to year: this facilitates the buildup of multiple records. Throughout my activities each nest found was recorded according to the formula: "under construction"; "fresh eggs present"; "with heavily incubated eggs"; "newly hatched young". In the course of bird photography one also found an excess of nests: this was necessary because perhaps only one in ten was at the right height, well lit, and at the right stage of the breeding cycle. The method of recording the status of each nest was continued. To assemble the data in Figures 2 and 3 all the records were recalculated to the specific stage "date of clutch completion and beginning of incubation" by means of established data on incubation and nestling periods in the different species (e.g., Marchant 1980). (In general the incubation and nestling periods of small passerines is 12–15, and 13–15 days; in shorebirds the former may be 31 days (Gwynne 1932). Allowing for some sloppiness in data gathering, a margin of error in reconciling individual records of plus or minus seven days must be allowed.

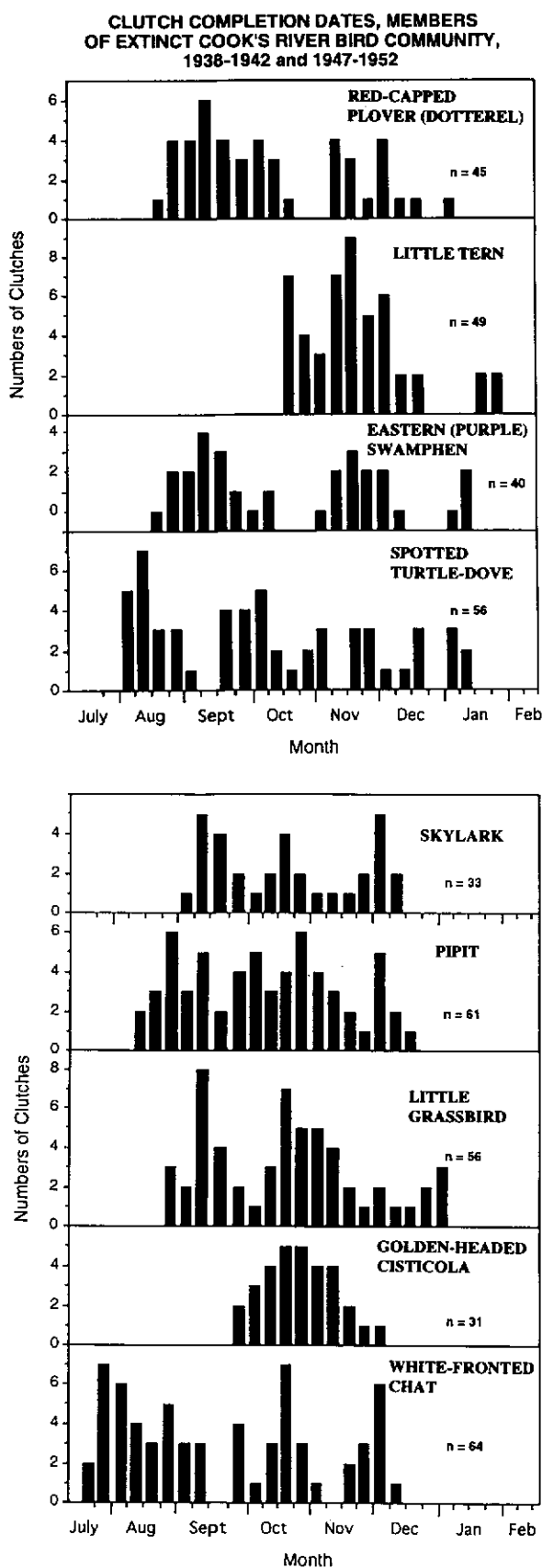


Fig. 2. Breeding seasons, as indicated by dates of completion of egg clutches and beginning of incubation, nine common Botany Bay saltmarsh and freshwater swamp species, plus the Little Tern. Data accumulated during 1930s–1940s.

CLUTCH COMPLETION DATES, SOME
TEMPERATE RAINFOREST SPECIES, WATERFALL AND
BOLACREEKS. Royal National Park, 1936-1942

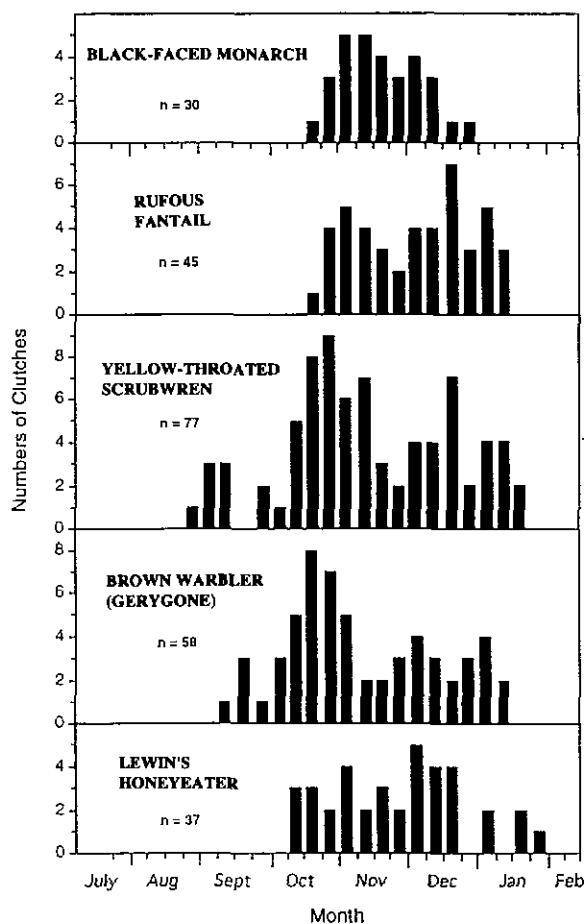


Fig. 3. Breeding times of five common temperate rainforest species, Waterfall and Bola Creeks, Royal National Park.

Breeding season data is given here only for the Cooks River saltmarsh/freshwater swamp, and Waterfall Creek rainforest bird communities. The former is relevant because the community no longer exists; the latter because, with the loss of the research Cabin in the Royal National Park, little field work is now carried out in rainforest. Hitherto no data on breeding times in these habitats has been published.

The habitat data (Table 1) is the outcome of extensive field work in the specific sites shown and throughout the County from the 1940s onwards, with considerable input from fellow ornithologists.

Bird names

For scientific names of the bird species (Christides and Boles 1994) see Appendix 1. Species lists follow their order. Where meritorious I follow English names used in the 1930s. Thus, "Bluewren" substitutes for

"Superb Fairy-wren", and "Peewee" for "Magpie-lark", because these remain in general use by the public. Familiarity helps the conservation cause. These species need names equivalent to "Willie Wagtail", "Silver-eye", and "Jacky Winter". The term "warbler" that, like "wren" and "robin", refers to a particular structural and ecological type of bird, is given precedence over "Gerygone". For consistency the second word in compound names is introduced by a small letter, e.g., "Cuckoo-shrike".

THE SYDNEY BIRD COMMUNITIES

Related to its being the original site of settlement, many of the descriptions and early paintings of Australian birds originated in Sydney. The first complete list of Sydney birds was published by the then ornithologist at the Australian Museum, A. J. North (North 1889): it contained 228 species. A subsequent list (North 1898) contained 263 species, with notes on status, habitat, and distribution.

The modern list of Hindwood and McGill (1958) covers 377 species, one-third of them being rare or chance occurrences. The authors relate individual species occurrence to vegetation by way of soil-type (Fig. 1). A broad correlation between the four habitat categories used and some of basic vegetation formation categories of Benson and Howell (1990) is obvious.

My account views changes in the Sydney avifauna in terms of four major habitat associations. These are:

- i) the saltmarshes and freshwater swamps of Cooks River and Botany Bay;
- ii) the tall eucalypt forests of the Upper North Shore;
- iii) woodlands of the Cumberland Plain west of Sydney;
- iv) the temperate rainforests of Waterfall Creek, Royal National Park.

The first three areas have now been destroyed or largely alienated as bird habitats. They formerly had rich and diversified bird communities, as acknowledged by the frequent visits to them by Sydney ornithologists in the 1930s and 1940s. The first two are treated in detail because I worked closely with them. Hawkesbury sandstone birds are not discussed: they and their habitat remain intact today.

Saltmarsh persists today as a large and viable tract on Towra Point (Fig. 1). The tall forest habitat of the North Shore is represented

Table 1. Birds of Sydney, use of four forest and woodland habitat types, residence and breeding, 1930–1960 data. Abundances in habitat: XXX — common; XX — moderate numbers; X — rare; x — very rare; r — visibly rarer than before, e — effectively eliminated.

Species	Habitat			
	Tall forest Upper North Shore	Heathland sandstone	Woodland Doonside	Temp rainforest Royal National Park
Black Bittern			Xe	
Painted Button-quail	XXe		XXe	
Bush Stone-curlew			Xe	
Spotted Turtle-dove	XX		XX	
Brown Pigeon				XX
Emerald Dove				X
Wonga Pigeon				XX
Bronzewing		X		
Brush Bronzewing				X
Topknot Pigeon				X
White Cockatoo				X
Little Lorikeet	X		X	
Musk Lorikeet	x			
Crimson Rosella	X			XXX
Eastern Rosella	XX	X	XXX	
King Parrot				XX
Pallid Cuckoo	XX	X	XX	
Brush Cuckoo				X
Fan-tailed Cuckoo	XX	X	X	XX
Black-eared Cuckoo			xe	
Horsfield's Bronze-cuckoo	XX	X	XX	
Shining Bronze-cuckoo	XX	X	XX	
Koel	x			
Boobook Owl	XX	X	XX	X
Tawny Frogmouth	XX	x	XX	
Azure Kingfisher	X		X	X
Laughing Kookaburra	XX	XX	XX	
Sacred Kingfisher	XX	XX	XX	
Superb Lyrebird				X
White-throated Treecreeper	XXX	XX	XX	X
Brown Treecreeper			XXr	
Bluewren	XXX	XX	XXX	X
Variegated Wren		XXX		
Southern Emu-wren		XX		
Spotted Pardalote	XXX	XXX	XX	
Striated Pardalote			XXXr	
Pilotbird		Xr		
Rockwarbler		Xxr		
Yellow-throated Scrubwren				Xxr
White-browed Scrubwren	XXX	XXX	X	XXX
Large-billed Scrubwren				X
Chestnut-rumped Heathwren		XX		
Speckled Warbler			XXr	
Weebill			XXX	
Brown Warbler	X			XXX
White-throated Warbler	XXX	XX	XXX	
Brown Thornbill	XXX	XXX	XX	XXX
Buff-rumped Thornbill	X	XX	X	
Yellow-rumped Thornbill	XX	X	XX	
Yellow Thornbill	XX		XXX	
Striated Thornbill	XXX	X	XXX	X
Southern Whiteface			XXe	
Red Wattlebird	XX	X		
Little Wattlebird	XX	XXX		
Leatherhead	XX	XX	XX	
Regent Honeyeater			Xe	
Bell Miner	x			
Noisy Miner	X	X	X	
Lewin's Honeyeater	X			XXX
Yellow-faced Honeyeater	XX	XX		
Yellow-tufted Honeyeater	XXX	X		
Fuscous Honeyeater			XXX	
Black-chinned Honeyeater			Xr	

Table 1 — continued

Species	Habitat			
	Tall forest Upper North Shore	Heathland sandstone	Woodland Doonside	Temp rainforest Royal National Park
White-naped Honeyeater	XX	X	X	
Painted Honeyeater			Xe	
Eastern Spinebill	XXX	XXX	XX	XX
Scarlet Honeyeater	XXX			
Jacky Winter	XXXe		XXXr	
Red-capped Robin			XXe	
Rose Robin				XX
Hooded Robin			Xe	
Eastern Yellow Robin	XXX	XX	XXX	XXX
Eastern Whipbird	XX	X	XX	XX
Varied Sittella	X		XX	
Crested Shrike-tit	X		XXr	
Golden Whistler	XX	X	XX	XXX
Rufous Whistler	XXX	XXX	XXX	
Grey Shrike-thrush	XXX	XX	XXX	XX
Black-faced Monarch				XX
Leaden Flycatcher	X		X	
Restless Flycatcher	Xe		XXr	
Pewee	XXX	X	XXX	
Rufous Fantail			XX	
Grey Fantail	XXX	XXX	XXX	XXX
Willie Wagtail	XXX	XXX	XXX	
Black-faced Cuckoo-shrike	XXX	X	XXX	
Little Cuckoo-shrike			Xr	
Cicadabird	X		Xe	
White-winged Triller			Xr	
Olive-backed Oriole	XX	x	XX	
Masked Woodswallow			X	
White-browed Woodswallow			X	
Dusky Woodswallow	XX		XX	
Grey Butcherbird	XX	X	XX	
Australian Magpie	XX	XX	XX	
Pied Currawong	x			X
Australian Raven	X	X	X	
Spotted Catbird				XX
Satin Bowerbird	X			XXX
Zebra Finch			XXr	
Double-barred Finch			XXXr	
Red-browed Finch	XXX	XXX	XXX	X
Diamond Firetail			XXr	
Beautiful Firetail		X		
Silvereye	XXX	X	XXX	XX
Bassian Thrush	Xe			XX
Common Starling	XX	XX	XXX	
Common Myna	—	—		

by the remnant Cumberland State Forest at Pennant Hills, and as peripheral strips along the edge of, and within, the sandstones. The Doonside—St Marys woodlands do not have a direct modern counterpart although a small segment of it possibly survives near Prospect Reservoir (Jocelyn Howell, pers. comm.). The former Army property at Scheyville, used by H. F. Recher in his excellent studies, bears resemblance but lacks major elements such as the Eastern Whiteface, Hooded and Red-capped Robins and, when I last visited it, only a single pair of Brown Treecreepers remained. The remnant Castlereagh State Forest near Penrith is on Tertiary alluvium and not representative of this habitat. The temperate rainforest habitat remains intact.

The loss of the above sites deprives us of the chance to provide relative species abundance figures from today to compare with 50 years ago. The Royal Australasian Ornithologists' Union has in recent years sponsored large numbers of bird counts in a variety of habitats: such data will be invaluable in the documentation of future trends.

COOKS RIVER AND BOTANY BAY: SALTMARSHES AND FRESHWATER SWAMPS

Botany Bay is a drowned estuary. The terrain is sandy and is delimited to the west by sandstone. There are three entrant drainages:

- i) a chain of ponds and swamps extending south from Centennial Park, through the

Lakes and Eastlakes golf courses, to the old Waterworks Swamp and then the Bay;

- ii) the small Cooks River with its two tributaries, Muddy and Wolli Creeks, entering from the north-west and, not covered here;
- iii) Georges River that drains a considerable hinterland entering from the south-west.

The headwaters of the pond system were presumably originally covered by scrub or woodland but, judging from the discovery of an Emu sitting on eggs near modern Randwick by a hunting party in 1798, there must have been open terrain. Habitat change obviously began early. In 1845 Mahoot, one of the last survivors of the extinct Cooks River tribe, complained that he could then catch only one or two possums a day whereas formerly he had been able to collect the 20–30 pelts necessary for a rug in a week. The ponds, draining poor sandy soil, formed Sydney's water-supply from 1827–1886 after the Tank Stream proved no longer adequate. Initially the Lachlan Swamps, now in Centennial Park, were used, being subsequently supplemented by the Botany Swamps in today's Lakes and Eastlakes golf courses. In 1886 the Upper Nepean scheme commenced (Jocelyn Howell, pers. comm.).

The higher country along the western limits of the drainage originally supported fine forest. In 1833 the estate "Bexley" contained stands of much sought after turpentine, ironbark, stringybark, and other eucalypts, and in 1880 the bush at Arncliffe was rich in native flowers (Benson and Howell 1990). Wolli Creek, with its rich alluvial soils, must have supported Swamp Mahogany, Swamp Casuarina, *Melaleuca linariifolia*, Lilli-pilli and, presumably, Livistona Palm (Benson and Howell). Obviously these habitats formerly contained a diversified avifauna. Loss would have matched clearing. However, as late as 1931, as a nine-year old, I heard Whipbirds singing from valley floor thickets between Forest Road, Bexley, and the East Hills railway line to the west. A few remnant Jacky Winters bred at Wolli Creek until the early 1940s (Table 2).

Freshwater marsh habitats

These were formerly one of the east coast major systems, with a diversified birdlife. In the 1920s A. J. North regularly visited the Sydney markets seeking rare waders shot by commercial hunters there. In the 1930s and 1940s they were important water-bird habitat, especially during times of drought inland.

Table 2. The birds of lower Wolli Creek; Arnold McGill's occurrence and abundance list based on 300 surveys made between 1941 and 1964. N = nesting records.

Recorded on 100% of trips

White-faced Heron, Black Duck, Dusky Moorhen (N), Purple Swamphen (N), House Sparrow, Starling.

Recorded commonly (e.g., 60–80% of trips)

Little Pied Cormorant, Nankeen Kestrel, Silver Gull, Spotted Turtle-dove (N), Laughing Kookaburra, Welcome Swallow (N), Pipit (earlier trips, N), Red-whiskered Bulbul, Reed Warbler (N), Golden-headed Cisticola (N), Blüewren (N), Willie Wagtail (N), Silvereye (N), Yellow-faced Honey-eater (winter), Goldfinch (earlier trips), Peewee (N).

Recorded regularly (30–40% of trips)

Australasian Grebe, Little Black Cormorant, Great Egret, Nankeen Night Heron, Australian Coot, Spurwinged Plover, Black-fronted Dotterel (earlier trips, N), Hqrsfield Bronze-cuckoo, Skylark (earlier trips), Black-faced Cuckoo-shrike, Little Grassbird (N), Yellow Thornbill, Yellow-tailed Thornbill (N), Jacky Winter (earlier, N), Brown Honeyeater (winter), Eastern, Spinebill, Common Myna (became progressively more common during survey), Raven.

Recorded on about 10% of trips

White-necked Heron, Japanese (Latham's) Snipe, Sharp-tailed Sandpiper, Pallid Cuckoo, Fan-tailed Cuckoo, Fairy Martin (nested early in survey).

Recorded on about 4–7% of trips

Great Cormorant, Mangrove (Striated) Heron, Straw-necked Ibis, Grey Teal, Black-shouldered Kite, Brown Goshawk, Golden Plover, Spine-tailed Swift, Azure Kingfisher, Sacred Kingfisher, Dollarbird, White-backed Swallow, White-fronted Chat (up to 1946), Restless Flycatcher, Spotted Pardalote, White-naped Honeyeater, Red Wattlebird, Grey Fantail, Red-browed Finch, Spice Finch, Black-backed Magpie.

Recorded on 1–3% of trips

Hoary-headed Grebe, White Ibis (arrived late in period), Banded Landrail, Little Tern, Baillon's Crake, Marsh Tern, Yellow Robin, Chestnut-breasted Finch (N), Tree Martin, Scarlet Robin, Scarlet Honeyeater.

Recorded on <1% of trips

Pelican, Brown Bittern, Royal Spoonbill, Black Swan, Chestnut Teal (late in survey), Little Falcon, Brown Falcon, Greenshank, White-headed Stilt, Common and Crested Terns, Shining Bronze-cuckoo, Koel, Striated Thornbill, Brown Thornbill, Rose Robin, Leaden Flycatcher, Golden Whistler, Rufous Whistler, Grey Shrike-thrush, White-plumed Honeyeater, Fuscous Honeyeater, Grey Butcherbird, Pied Currawong, Grey Currawong, Peaceful Dove, Crimson and Eastern Rosellas, Red-backed Parrot.

Regularly occurring, though not breeding, were both species of Spoonbill, the three Egrets (Cattle Egrets had not then colonized Australia), White-eyed Duck, or Hardhead, Shoveller, Musk Duck, Wood Duck, Grey Teal (though not the Chestnut Teal), Black Swan, Coot, Australasian Bittern and, sometimes, Little Bittern and Crakes. The main breeders were the Purple Swamphen, Moorhen, Black

Duck, Reed Warbler, and Little Grassbird. The lower ponds of the system were kept open by the small tanneries and wool-scouring works that used the water. Today land-fill associated with airport development has largely isolated and constricted the Waterworks Swamp which is choked with vegetation: open water areas are proportionately reduced.

Further south, adjacent to Muddy Creek, was the extensive Moorefield Swamp. It extended east and south from the old racecourse for some two km to Sandringham and Sans Souci. Water depth was 1–2 m and much of the surface was covered with the introduced Water Hyacinth interspersed with clumps of rushes.

At any time the surface of the swamp was dotted with Purple Swampphens, with up to a dozen active nests being found per morning. Black Ducks, Swans, White-fronted Herons, Egrets, Moorhens, and Baillon's Crakes. Reeded sections supported high populations of Reed Warblers and Little Grassbirds. Moorefield swamp was virtually unstudied by ornithologists who preferred to focus on the Botany Swamps. It was drained and converted to housing in the 1960s.

Muddy Creek: saltmarsh and mangroves

The feature of the southern side of Cooks River was the square kilometres, or more, of magnificent saltmarsh. Because of its "obnoxious" nature, extensive flats of sticky black mud, intersected with innumerable channels water-filled at high tide, and drab stunted vegetation, this had been shunned by man for a hundred years... until it was needed for the airport in the 1950s and 1960s. "... Samphire or Glasswort *Sarcocornia quinqueflora*, Seablite *Suaeda australis*, *Isolepis nodosa* (formerly *Scirpus nodosus*), the Salt Couches *Sporobolus virginicus* and *Zoysia macrantha* (formerly *pungens*) and patches of *Juncus kraussii* provided extensive vegetation cover. Ringlets (White-fronted Chats) and Banded Landrails (Buff-Banded Rails) nested in the *Suaeda australis*, mainly in bigger plants along the low ridges, and *Isolepis nodosa*, respectively, and migratory waders fed in the channels at low tide". Cisticolas were abundant in the scrubby vegetation along the edges and used the saltmarsh to some extent. The saltmarshes extended up the entrant creeks and formed the most interesting of Muddy Creek's habitats.

Muddy Creek was the writer's main bird study site in the 1930s, early and late 1940s, and early 1950s, and over much of this period

transects were walked along one or another part of it at weekly intervals. The Creek, 3 km in length, originates as a small drainage extending beneath the railway line between Rockdale and Kogarah. It is today a concrete stormwater canal.

In the 1930s it passed through open, seasonally flooded, paddocks in the upper reaches, extensive silted flats being used as Chinese market gardens, then finally saltmarsh. Midstream reedbeds rang with the songs of Reed Warblers and Little Grassbirds. Each road bridge had pairs of nesting Welcome Swallows. The Chinese lived in the old stone house known historically as the Wilson Farmhouse (that still stands): it was built on the site of that of the original settler of the 1850s, John Bowman. Every pond in the market gardens had good populations of the Green-and-Golden Bell Frog *Litoria aurea*, now a vanishing species restricted to 16 small populations from its entire range (G. Pyke, pers. comm.). Peewees and Pipits fed in the gardens. Adjacent relic stands of Swampoak *Casuarina glauca* and Swamp Mahogany *Eucalyptus robusta* were the nesting places of Peewees and Willie Wagtails, and were used by the Horsfield Bronze-cuckoo to loudly assert its "host-parasite" rights to the nests of the chats in the saltmarsh across the creek. Boxthorn and Blackberry thickets had nesting Bluewrens and Spotted Turtle-doves.

At Bestic Street, a kilometre before its entrance into the main river, Muddy Creek broadened into a salt water expanse. The eastern bank now supported a line of tall Grey Mangroves with breeding Silvereyes, wasteland with Lantana and Inkberry, grassbirds and wrens, and a further expanse of Chinese market garden. On the western side residue from earlier dredging had converted former saltmarsh into a large park (Barton Park). A central sandy section of about 5 000 m² annually supported two or three breeding pairs of Red-capped Plovers and around the grassed periphery 4–5 Pipits and Skylarks could be flushed from nests in a morning's walk.

Birdlife was rich and diversified along Muddy Creek in the 1930s, so much so that many children were egg-collectors. An index of relative abundance is suggested by the ease with which a child obtained the eggs of species: typically an egg collection would be built up as follows: House Sparrow, Spotted Turtle-dove, Starling, Bluewren, Silvereye, Welcome Swallow, "Ringlet", Pipit or Skylark (we failed to recognize the difference), Willie

Wagtail, Reed Warbler, Red-whiskered Bulbul, "Futfut" (i.e., *Cisticola*), Swampphen, Black Duck, Little Grassbird, Red-capped Plover and exceptionally, Buff-banded Rail and "Blue Crane" (White-fronted Heron). Common Mynas, now exceedingly common, were restricted to a small population near the Sydney Showground in the 1930s and 1940s, and no child ever obtained their eggs. Those of the Little Tern that in the late 1940s had a breeding colony on the main river were unknown.

The White-fronted Chat was a particularly common species wherever there was saltmarsh, and each semi-isolated pocket of this had a group of breeding birds. The birds nested in taller clumps of *Suaeda australis* (the preferred site), and sometimes in clumps of *Isolepsus* and dense hanging masses of introduced *Pennisetum clandestinum* (Kikuyu) grass where it grew along drainage channels. By skirting these preferred sites at weekly intervals and flushing the sitting female it was easy both to get figures for breeding densities and times. Three circumspect tracts of saltmarsh contained, in September–October 1939, 1940, 1950, and 1951, counts of active chat nests averaging 10.4, 8.3, 5.6, and 6.2 per 5 000 m². Regularly 20–25% of nests contained eggs of the Horsfield Bronze-cuckoo; this compares with the 8% found by Major (1991) for his Melbourne study-site. In wider sections of saltmarsh where the plants were more stunted, breeding densities were only half to one-third of the above figures: these areas, however, were extensively used in foraging.

Cisticola breeding numbers in low shrub, waste-country terrain fringing the marsh were estimated, from numbers of aerial displaying males, as 2–4 pairs per 5 000 m².

Breeding season data for the common Muddy Creek species based on nests found is shown in Figure 2. Regularly the chats started in late July–early August; the doves, pipits, swampphens, and plovers, in August; the *Cisticolas* and Little Terns (first found nesting in 1949–1960) in October. Most species were obviously double-brooded, and some may have occasionally been triple-brooded. Note that the Chat is also a late-winter breeder elsewhere in its range (Sharland 1924; Davies 1979; Major 1991), and is typically double-brooded (Major 1991). Red-capped Plovers often raise three broods (Davis and Reid 1964). The dove is an erratic breeder and may nest at any time (Frith *et al.* 1976).

The birds of lower Wolli Creek, degraded woodland and swampland

The lower section of this creek, between Turrella and Bardwell Park railway stations, and 1.0–1.5 km upstream from its junction with the main Cooks River, was Arnold McGill's main study site over the 20-year period from 1940 to 1960, some 300 visits being made at all seasons. Table 2, adapted from the list kindly supplied me by McGill, both helps define the earlier Cooks River fauna and documents the avifauna at the then stage of environmental degradation.

There is no comprehensive early settlement bird list from Wolli Creek although Gifford Eardley (undated) writing in "The Early History of the Wolli Creek Valley" noted the occurrence of numerous water-birds, the same species still present in McGill's day. A. J. North earlier recorded the taking of eggs of the Grey Shrike-thrush and a Pallid Cuckoo egg from a nest near Wolli Creek, that White-fronted Chats nested at Canterbury and that the Whipbird was common in scrubby thickets in the valley (Rankin 1989).

By the 1940s, when Arnold first introduced me to the area, the original vegetation, as indicated by Benson and Howell, had been degraded to a few remaining Red Angophora, Swamp Mahogany, and Swamp Casuarina trees, tangles of introduced Castor-oil Plant, Lantana, Blackberry, rank grasses, and a few persistent native shrubs like Sydney Golden Wattle and *Eriostemon*. There were tracts of dense reedbed centrally. Thus, to forest species it was already severely degraded habitat, to the water-birds it represented the upper limits of feeding area.

Table 2 shows that:

1. One hundred and eight species of birds were recorded in the 300 trips, only 39 species were seen on 30% or more, 29 were recorded only once or twice.
2. Forest birds by the 1940s had virtually ceased to use the area; at this time the last pairs of Jacky Winters stopped breeding; thicket-inhabiting Bluewrens bred at least into the late 1950s.
3. Forest birds continued to visit Wolli Creek as wanderers or nomads in autumn and winter but most only rarely and on an "accidental" basis. More regular were the Black-faced Cuckoo-shrike and honey-eaters that came to feed on the flowers of the introduced *Erythrina* trees.

4. Of the 23 non-waterbirds that were regularly encountered, several (e.g., Kestrel) were inhabitants of open terrain, not forest. The Pipit was not recorded breeding after the first years.
5. Amongst the water-birds Swampheens and Reed Warblers continued to breed along the Creek throughout; others only occasionally visited this upstream site.
6. The number of species using the site decreased over the 20-year period (e.g., Common Goldfinch). The Common Myna became progressively more common.
7. In contrast to habitat specialists that disappear with loss of basic conditions several hardy and adaptable "opportunistic" species (e.g., Wagtail, Peewee, Kookaburra) persisted, sometimes attempting to breed.

The breeding season of birds, Cooks River

Figure 2 summarizes the clutch completion dates for nine common species from the writer's records (data from 1938 to 1942 and 1947 to 1960). Laying started in August or September (later in Cisticola and migratory Little Tern), and ended usually in December with the onset of hot, dry, weather. The Chat was an early breeder, as it is elsewhere in the range (Sharland 1924; Davies 1979; Major 1991). The protracted season in the introduced Turtle-dove can be linked to it being an "erratic" breeder (Frith *et al.* 1976).

From the distribution of egg-laying most species emerge as double-breeders. Major (1991) found the Chat to be regularly double-brooded. Davis and Reid (1964) document three, sometimes, four broods in the plover in a season, but some of these presumably represent re-nesting after failure.

The 4–5 month long breeding season in most species is probably partly an artifact of grouping data from several years: in the Chat the season varies in length between years (Major 1991).

The contemporary Botany Bay avifauna, 1993–1995

The contemporary avifauna of Botany Bay has been explored in the summers of 1993 to 1995 by means of walked transects through the different parts, with special attention to those studied extensively 50 years ago.

Freshwater swamps are largely gone. A small section remains at Centennial Park but, downstream, ponding, waterflow restriction and over-compact reedbed, breakup of the

Waterworks Swamp, and loss of the Moorefield Swamp, mean that the Bay is no longer a major waterfowl breeding, or seasonal refuge, area. A small area of "waste" reedbed adjacent to West Botany Street and market garden and the St. George Soccer Stadium maintains Reed Warblers and Little Grass-birds (Fig. 4).

A delightful innovation has been the creation of two new, if small, areas of swamp habitat on the western side adjacent to West Botany Street, the Spring Creek Wetlands and Eve Street Marsh by the Rockdale Council and Sydney Water Board respectively. Both are extensively used by birds, with Swampheens, Moorheens, grassbirds and Reed Warblers, migratory Sharp-tailed Sandpipers, and foraging Stilts and Chestnut Teal making the most of the combination of open water, reedbed and mudflat. An extensive artificial pond has been secondarily created at the base of the Kurnell Peninsula. It is understood that this was originally freshwater but was opened to the bay because of weedbed growth. The status of this might be re-examined.

The saltmarsh habitat of Cooks River is totally gone save for a minuscule section adjacent to the soccer stadium above. This retains an almost complete set of typical saltmarsh plants (Fig. 5) but is too small to be used by Chats. A party of stilts fed there in January, 1995. Adjacent "waste" terrain (Appendix 2) supports Cisticolas, Pipits, and Yellow-rumped Thornbills.

A square kilometre of saltmarsh remains on Towra Point at the southeastern end of the Bay (Fig. 6). It replicates the Cooks River saltmarsh. Along a 2 km section of tract through this marsh Steve Anton-Smith and I counted 20 Chats in parties of 2–5 in January, 1995.

The strip of mangroves along the eastern side of the salt-water section of Muddy Creek remains as the only part of the original habitat. Silvereyes remain abundant feeding on Lantana berries along the adjacent waste-land strip and there are Bluewrens in the thickets along the edge of the market gardens. Eucalypt saplings planted by the Council adjacent to the fishing club support Wagtails and visiting New Holland and White-plumed Honeyeaters. An extensive section of "aircraft flight path" to the south of Cooks River has now been fenced off: it is degraded habitat of exotic weeds and shrubs but has a good Cisticola population, some Pipits; though Common Mynas and Starling are the main inhabitants.



Fig. 4. Dense reedbed *Phragmites australis* without open water, edge of Barton Park, Muddy Creek. Such pockets occur along the old Eastlakes-Waterworks drainage where there is now minimal water-flow. Such degraded marshland habitat supports Reed Warblers and Little Grassbirds. January 1995. Photo by author.



Fig. 5. A last remnant of the formerly extensive Cooks River saltmarshes, adjacent to St George soccer stadium. The area is too small to support White-fronted Chats but waders occupied the pools in January, 1995 and Cisticolas the adjacent shrubbery. Photo by author.



Fig. 6. Extensive saltmarsh and mangrove *Avicenna marina*, Towra Point Nature Reserve, January, 1995. Photo by author.

Notable successes have been achieved by small plantings of native trees and habitat recreation, e.g., at the Eve Street Marsh and Bonnie Doon golf course. *Melaleuca* and *Casuarina* at the former support Yellow Thornbills; at the golf course and elsewhere, much larger populations of Willie Wagtails, Peewees, and Yellow-rumped Thornbills than ever existed previously. Rockdale Park, with its native and ornamental trees had visiting New Holland Honeyeaters, Little and Red Wattlebirds, a Galah, Figbird, two Magpies, plus Peewees and Wagtails, and aerial feeding Welcome Swallows in January, 1995.

In later years Rankin (1989) and co-workers have carried out monthly assessments of the birds of the Lower Wolli Creek Valley, starting in January, 1982, and focusing on tiny secondarily created reserve areas: Girrahween Park near Bardwell Park railway station, Coolabah Reserve between Bardwell Park and Turrella, Nannygoat Hill to the west of the railway line, and Waterworth Park near Tempe. Up to 1988 the number of bird species recorded in each was 20, 47, 90, and 26 species. The overwhelming bulk were occasional seasonal visitors but from my knowledge of the habitat the number of breeding species is perhaps only 15. This, however, needs study. Rankin lists the number of bird species recorded in three periods, 1940–1969 (the McGill era), 1970–1981, and 1982–1988: the totals are 130, 92, and 122. Species recorded breeding accord well with the list from McGill's day: Black Duck, Chestnut Teal (a new arrival), Dusky Moorhen, Black-fronted Dotterel, Welcome Swallow, Australian Pipit, Blackbird (a new arrival), Willie Wagtail, Golden-headed Cisticola, Bluewren, Yellow-rumped Thornbill. In these later surveys the following species have been recorded on 50%, or more, of visits: Little Black and Little Pied Cormorants, White-faced Heron, White Ibis, Black Duck, Chestnut Teal, Brown Goshawk, Dusky Moorhen, Silver Gull, Rock Dove, Spotted Turtle-dove, White Cockatoo, Fan-tailed Cuckoo, Horsfield Bronze-cuckoo, Laughing Kookaburra, Welcome Swallow, Pipit, Black-faced Cuckoo-shrike, Eastern Yellow Robin, Willie Wagtail, Reed Warbler, Cisticola, Bluewren, Yellow Thornbill, New Holland Honeyeater, Spinebill, Spotted Pardalote, Silvereye, House Sparrow, Red-browed Finch, Nutmeg Mannikin (an aviary escapee), Starling, Common Myna, Peewee, Magpie, Pied Currawong, Australian Raven. Recorded on one-third to half the trips were: Little Grebe, Pacific Heron, Great Egret, Grey

Teal, Black-shouldered Kite, Kestrel, Swamp-hen, Galah, Rainbow Lorikeet, Crimson Rosella, Grey Fantail, Yellow-rumped Thornbill, Red and Little Wattlebirds, Yellow-faced and White-plumed Honeyeaters, Goldfinch, Grey Butcherbird.

Species visibly less abundant (or absent) since the 1940s are the Swamp-hen and Chat. Now abundant but rare, or absent formerly, are the White Ibis, Chestnut Teal, Galah, White Cockatoo, Blackbird, and Nutmeg Mannikin, and, surprisingly Red-browed Finch (now a breeder) Spotted Pardalote, and Yellow Robin. The breeding status of the latter two species is not documented.

Gratifyingly, hence, the creation of the small reserves along Wolli Creek have led to not only the persistence of most of the species of the 1940s but some significant, if minor, improvements. The breeding species are those recognized as resilient to change from occurrences in similarly degraded habitats elsewhere. Lower Wolli Creek is still visited by a few nectar-seeking honeyeaters in autumn and winter as in other Botany Bay urban sites. Despite these small reserves the area was obviously lost as a viable forest bird habitat decades ahead of the McGill and Rankin studies.

The Towra Point Nature Reserve

This promontory out into Botany Bay contains extensive salt marshes and areas of mangrove: an elevated sandy central region has Swamp Oak, Bangalay *Eucalyptus botryoides*, tall *Banksia integrifolia*, some *Melaleuca ericifolia* and *M. quinquenervia*, *Exocarpos*, and much shrubbery (Fig. 7). As an environment it is not particularly attractive: the approach is along a muddy tract flooded at high tide, there is a superabundance of saltwater mosquitos, and large web-spinning *Nephila* spiders occur in the mangroves, but the area is excellent for birds. Along a 2 km section of track through the varied habitats, allowing a 50 m wide strip on either side, the following bird species were recorded in January, 1995: Crimson Rosella, 5; Fan-tailed Cuckoo, 2; Horsfield Bronze-cuckoo, 3; Sacred Kingfisher, 3; Bluewren, 4–7; Variegated Wren, 3–8; Emu-wren, 14–15; White-browed Scrub-wren, 8; Brown Thornbill, 9; Yellow Thornbill, 10; Little Wattlebird, 5; Spinebill, 3; White-fronted Chat, 20; Yellow Robin, 3; Rufous Whistler, 4; Grey Shrike-thrush, 2; Peewee, 5; Willie Wagtail, 6; Cisticola, 9; Silvereye, 10–15. Old nests of the Red-browed Finch were seen.



Fig. 7. Core of dry scrub forest on sand, Towra Point. This seemingly unproductive habitat contains a good sample of what must have been the former forest avifauna of the rim of Botany Bay. Photo by author.

Towra Point contains one of the remaining two large areas of saltmarsh (other than on the Hunter River north of Sydney); only in these areas and at Homebush Bay are there viable Chat populations. It has a significant population of Emu-wrens. A small self-sustaining sample of the original forest bird community of Botany Bay is located here.

THE UPPER NORTH SHORE: TALL EUCALYPT FOREST

Tall rich eucalypt forest formerly covered the Wianamatta Shale Plateau from Wollstonecraft north to Wahroonga, Pennant Hills, and Castle Hill, being delimited on either side by the sandstones of Middle Harbour and the Hawkesbury, and the Lane Cove River (Fig. 1). Dominant trees were: Blackbutt *Eucalyptus pilularis*, Grey Ironbark *E. paniculata* and, in places, Sydney Bluegum *E. saligna*; the dryer ridges supported White Stringybark *E. globoidea*, Grey Gum *E. punctata*, Turpentine *Syncarpia glomulifera*, Rough-barked *Angophora floribunda*, the Mahoganys *E. acmenoides* and *E. resinifera*, and the Forest Casuarina *Allocasuarina torulosa*; whilst the damper gullies had some *Pittosporum undulatum* (Benson and Howell 1990). Creek edges supported dense shrubbery and open areas grassy substratum. Wildflowers were abundant. these tall forests maintained both a high floristic and microhabitat diversity.

In the 1930s and 1940s the upper North Shore still had large areas of natural forest; vacant lots along the roads retained tall trees

and good sapling growth; many roads terminated as "dead-ends" against a wall of forest; houses were scattered, and their gardens were rich in wild life. This was the Wahroonga I knew. Throughout the 1930s I spent much time at my grandmother's home, "Cedardale", at Pearces Corner, the junction of Pacific Highway and Pennant Hills Road. The home was characteristic of many: two-storied and rambling; with Bluewrens nesting in the climbing roses, Spinebills in the Honey-suckle, and Silvereyes seeking aphides in the nutritionally well-nourished hydrangeas by the distant toilet. There was a lawn of fragrant freesias in spring; a hedge of *Pittosporum* scented the summer evenings. By night Long-nosed Bandicoots fossicked on the lawn and fruit-bats competed for a rather second-rate crop of Granny Smith apples.

Walking the 2 km road to and from the Wahroonga railway station was a natural history experience. Spotted Pardalotes tunnelled into the earthen road-edge banks; Magpies carolled; and Striated Thornbills, Red Wattlebirds, and Jacky Winters nested in the still uncleared lots. A Tawny Frogmouth sat sedately on its nest in a giant road-edge Blackbutt; today this tree is still there but the frogmouth, like the pardalotes and thornbills, has been gone 30 years.

Of interest in the light of later changes was that, centred on an area of *Pittosporum*, was one of the few small "colonies" of Noisy Miners in the area: this contemporarily dominant species was not in the top 10 in terms of

abundance in the 1930s. The other latter-day dominant, the Pied Currawong never bred in my experience; they were autumn-winter visitors to feeding on the ornamental figtrees.

The Wahroonga forests supported over 60 breeding species of birds (Table 1), including 11 honeyeaters, five thornbills, and four cuckoos. Such richness was a boon to egg-collecting children who after a couple of springtimes might have the eggs of up to 30 species. Starting from scratch a typical "order of acquisition" of the eggs of species might have been: Yellow Robin, Bluewren, Starling, Sparrow, Red-browed Finch, Grey Fantail, Willie Wagtail, Yellow-rumped Thornbill, Peewee, Golden Bronze-cuckoo, Spotted Pardalote, Jacky Winter, Yellow-tufted Honeyeater, Golden and Rufous Whistlers, Striated and Brown Thornbills, Grey Shrike-thrush, Dusky Woodswallow, Eastern Spinebill, White-throated Warbler, Sacred Kingfisher, Grey Butcherbird, Magpie, Kookaburra, Tawny Frogmouth, Eastern Rosella, Buff-rumped Thornbill, Rockwarbler, Horsfield Bronze-cuckoo, White-browed Scrubwren, Boobook Owl. The build-up of such a collection required, of course, wandering over several square kilometres. Within the "bush" there was much microhabitat separation of species. Olive-backed Orioles, Grey Butcherbirds, and White-throated Treecreepers kept largely to the taller forest; Yellow-tailed Thornbills to patches of pine and eucalypt sapling in fields; Bassian Thrushes to a few semi-rainforest upper gullies of the Lane Cove; Rockwarblers and Buff-rumped Thornbills to the sandstone country.

Breeding density figures for two structurally diversified plots (characterized by tall trees, tall saplings, thickets and open sections) were subsequently developed. In October 1939, 1940, and 1941, in one 50 000 m² section nests were found as follows: Tawny Frogmouth — 1,1,1; Bluewren — 2,3,2; Spotted Pardalote — 1,1,1; Striated Thornbill — 2,2,1; Brown Thornbill — 1,1,1; Yellow Robin — 1,2,1; Golden Whistler — 1,1,1; Rufous Whistler — 1,1,0; Grey Fantail — 1,1,2; Red-browed Finch — 2,2,3; Silvereye — 1,1,2.

A larger 250 000 m² section of gentle hill slope, somewhat open (Fig. 8) Wood-swallow, Yellow-tufted Honeyeater, and Painted Button-quail habitat that merged into dense creekside thickets contained active nests in October 1939, 1940, and 1941, as follows: Button-quail — 1,1,1; Black-faced Cuckoo-shrike — 2,2,3; Yellow Robin — 2,2,1; Grey Shrike-thrush — 1,1,2; Eastern Whipbird — 1,1,1; Dusky Woodswallow — 2,2,3; Grey Fantail — 2,2,2; Spotted Pardalote — 2,2,1; Yellow-tufted Honeyeater — 2,2,3; Regent Honeyeater — 0,1,0; Yellow-faced Honeyeater — 1,0,0; White-naped Honeyeater — 1,0,0; Leatherhead (Noisy Friarbird) — 1,1,1; Red-browed Finch — 3,2,3; Bluewren — 2,2,1; White-browed Scrubwren — 0,1,1; Striated Thornbill — 2,1,1; Brown Thornbill — 1,0,1; White-throated Warbler — 1,1,0; White-throated Treecreeper — 1,0,0.

Thus, the smaller plot contained 11, and the larger 20 breeding species, allowing that obviously some nests were not found. The



Fig. 8. Tall forest, secondarily opened out, between Lucinda and Ada Avenues, Wahroonga, highly productive bird habitat in the 1930s and 1940s. Photo by author.

smaller plot averaged 15 breeding pairs per 100 000 m²; the larger, more speciose one 10. It should be stressed that these plots were chosen for analysis (actually photography) because they were unusually rich. A paddock of homogeneous dense overgrown thicket adjacent to the former and of equivalent size to it had only five breeding pairs in four species, as best could be determined. General observation suggested that hillside forest within the sandstone areas of the upper Lane Cove catchment probably had only 1/5–1/10 the density of breeding birds per unit area as the large plot above.

The upper North Shore areas I studied lacked the rainforest species of Waterfall Creek, except for a few Brown Warblers and Bassian Thrushes; many Cumberland Plain species were absent (Table 1). The Satin Bowerbird was rare; and there were very few Lyrebirds in the upper Lane Cove gullies.

Post-war, the forests and bushland of the upper North Shore progressively gave way to housing; the old dirt roads were widened and sealed; soon no tracts of natural forest, nor vacant lots along the roads remained. Today one walks the roads of Wahroonga and Turramurra and many of the giant old trees remain. Instinctively I search for the nesting thornbills and pardalotes, the singing Jacky Winters that so enlivened the spring mornings, the animated Spinebills and raucous Leatherheads. Even the Bluewrens are gone. Instead, still-shaded streets with their tall trees ring with the strident protests of the dominating Noisy Miners, the melodious squawks of the introduced Common Myna, and the shrill shrieks of the garden-fed Rainbow Lorikeets. Pied Currawongs, Magpies, Grey Butcherbirds, and Kookaburras, are the prominent species. Small birds are largely gone although they occur, seemingly in modest numbers, in the adjacent sandstone.

The Wollstonecraft Gully

This half a kilometre long tract of forest between the North Shore railway line and Greenwich, close to the city and maintained as a reserve by the North Sydney Council, merits mention as it illustrates some of the problems of small reserves. I first visited it in the early 1930s when an aunt and uncle of mine built a house on the Greenwich side; the gully was relatively pristine and contained stringybark, ironbark, Forest Casuarina, turpentine, and there was a clean-water

valley-floor creek. On the eastern side houses hugged the road edge heaving several hundred metres of open forested slope behind. Most homes had an attendant Blue-tongued Lizard, and Ringtail and Brushtail Possums were frequent nocturnal visitors.

In 1936 three pairs of Sacred Kingfishers nested in arboreal termite mounds in the gully; Spotted Pardalotes tunnelled into any new bank; Grey Fantails, Spinebills, White-throated Warblers, Rufous Whistlers, and Striated and Brown Thornbills were prominent breeding species. Bluewrens and Yellow Robins were common in the gully-floor thickets. (There were, however, no Tree-creepers, so obviously there had already been some retreat of species).

Environmental changes proceeded as follows. The Reserve became increasingly isolated as housing development in the adjacent suburbs accelerated. By the 1950s soot-laden air from the Pyrmont Powerhouse and other sources carried up the gully from the harbour began killing the terminal foliage of all the taller eucalypts: this was the feeding substrate of the Striated Thornbills and pardalotes and their numbers dropped. Large condominium that extended right down towards the creek replaced houses and the breeding areas of the Spinebills, Rufous Whistlers, and White-throated Warblers. With increased human encroachment the creek became degraded. By the 1960s kingfishers no longer bred. Bluewrens became increasingly less common, as was the case with the Ringtailed and Brush-tailed Possums. Yellow Robins and Silvereyes remained common in the valley-floor thickets of Pittosporum, Privet, and Lantana until the late 1980s. Then, following a molestation incident, the Council cleared the undergrowth, eliminating their habitat.

Today the gully continues to support exuberant tree growth and to the average viewer is an excellent example of natural forest. But as a natural community it is degraded. The Blue-tongue Lizards, Kingfishers, Pardalotes, and Thornbills are long since gone, though possums remain. Birds are abundant but the bird community is highly abnormal being composed of Noisy Miners which are very abundant, Pied Currawongs, Rainbow Lorikeets, a few Silvereyes, and single pairs of Grey Butcherbirds, Magpies and Kookaburras. Several of these species are fed by householders. Berry-eating Currawongs have spread the Tree Privet and Lantana widely. In terms of small birds it is an ornithological desert.

THE CUMBERLAND PLAINS WOODLAND

Until the early 1950s, when clearing for housing became massive, extensive tracts of parklike woodland, interspersed with fields, characterized the Cumberland Plain between Kellyville and the Nepean River. The best tracts were around Doonside, Blacktown, and St Marys and formed major study sites for Sydney ornithologists. Major trees were: Grey Box *Eucalyptus moluccana*, Forest Redgum *E. tereticornis*, Narrow-leaved Ironbark *E. crebra*, and the teatree *Melaleuca decora* that hosted high populations of the Mistletoe *Amyema gaudichaudii*. There were sluggish but rich creek drainages with pools, and creekside thickets of *Bursaria* and other shrubs. The substratum for the most part was grassy.

The woodlands were exceptionally rich in birds (Table 1), with a combination of more coastal forest species and upwards of 15 Western Slopes forms that within the County only occurred here. These included: Little (White-breasted) Cuckoo-shrike, White-winged Triller, Brown Treecreeper, Red-capped and Hooded Robins, Speckled Warbler, Eastern Whiteface, Black-eared Cuckoo, White-winged Chough, Red-rumped Parrot, Black-chinned and Fuscous Honeyeaters and, in some years, Regent and Painted Honeyeaters. The open fields supported Bush Stone-curlew, and Banded and Masked Plover (Lapwing). Mistletoebirds fed annually on *Amyema* and were very abundant. In years when White-browed and Masked Woodswallows invaded the coast this was their favoured area of concentration.

On an average spring day the nests of 15 species could easily be found. The richness of the bird community is illustrated by the following. In October, 1957, in anticipation of a field trip for members of a University course group, I challenged the veteran local ornithologists, Ernie Woods and Johnno Rhodes to produce for us the maximum number of nests they could find. A week later, in a 400 000 square metres timbered paddock they produced the following active nests: Black-faced Cuckoo-shrike, 2; Little Cuckoo-shrike, 1; White-winged Triller, 1; Hooded Robin, 1; Yellow Robin, 2; Rufous Whistler, 2; Grey Shrike-thrush, 1; Restless Flycatcher, 1; Grey Fantail, 2; Willie Wagtail, 2; Bluewren, 2; Speckled Warbler, 1; White-throated Warbler, 2; Buff-rumped Thornbill, 1; Brown Tree-creeper, 1; Noisy Friarbird, 2; Fuscous Honeyeater, 2; Diamond Firetail, 2; Double-barred Finch, 2; Peewee, 1; Grey Butcherbird, 1.

This represented 32 nests in 21 species and was fairly typical of the habitat.

Losses of birds that were formerly common in the St Marys-Doonside area have been documented by John Farrell, Keith Egan, and David Pepper Edwards (list kindly supplied by Alan Leishman) as follows: Hooded Robin — last record May 5, 1973; previous records October 3, 1938, July 28, 1940, February 10, 1957; May 25, 1958; May 3, 1970; Red-capped Robin — February 16, 1947 and April 12, 1953; but three birds were seen by Dick Turner in the Castlereagh State Forest two years ago; Black Bittern — observed June 22, 1972; June 6, 1973, September 21, 1974, and mist netted May 24, 1992 and April 11, 1993. There have been no records of the Whiteface in the last thirty years. The Speckled Warbler has, however, been recorded breeding at Scheyville in recent years by H. F. Recher.

THE TEMPERATE RAINFORESTS OF WATERFALL AND BOLA CREEKS

In valley floors of the deeper sections of the Royal National Park the exposed Narrabeen shales support temperate rainforest. (The actual area is much smaller than that suggested in Fig. 1). The softwood vegetation of lillypilly, coachwood, and other trees (Fig. 9) contrasted to that of the adjacent tall eucalypt forests (Fig. 10).

Unique to the rainforests are over a dozen species, most of them of northern origin: Black-faced Monarch; Rufous Fantail; Green Catbird; Wonga, Brown, and Emerald Pigeons; Bassian Thrush; Large-billed and Yellow-throated Scrubwrens; and Brown Warbler. Topknot Pigeons made frequent visits to feed on the fruits of the Bangalow Palm. Satin Bowerbirds and Lyrebirds were common.

From the late 1920s onwards the Royal Zoological Society's Cabin (Fig. 9) was a major study site for Sydney ornithologists (for publications see Chaffer 1929, 1930; Marshall 1930, 1954).

The breeding season data (Fig. 3) for the birds of this habitat is based on 23 trips of two to four days duration that the writer made between 1939 and 1942 in association with colleagues. The season starts relatively late in these rainforests; Black-faced Monarchs and Rufous Fantails initiated breeding in October. It commonly continued into January in this sheltered deep valley environment (see also Marshall 1930). Lewin's Honeyeater, a berry feeding resident, also started and finished late.



Fig. 9. Zoologists' Cabin, backed by creekside temperate rainforest, Waterfall Creek, October, 1929. Roy Cooper is in the foreground. Photograph by Albert Gwynne.



Fig. 10. Forest along the road immediately above the Zoologists' Cabin on Waterfall Creek, Royal National Park, June 1931. Photograph by Albert Gwynne.

The Royal National Park bird community remains intact although numbers of some of the bird species seem to be down.

THE HABITAT FACTOR IN BIRD SPECIES ABUNDANCE

The occurrence of bird species is closely related to vegetation type. The habitats represented by the major plant formations provide the basic needs of species: cover,

perching and feeding substrates, food types, nesting sites. To judge from the way each habitat is occupied by a co-occurring suite of species, most of the needs are common to all species. Many species, however, have specific needs and occurrence is linked to the latter. Examples are the need for undergrowth by the White-browed Scrubwren and mistletoe berries by the Mistletoebird. On the other hand some generalists are linked to a resource

that is not limited by habitat boundaries, e.g., the opportunistic Willie Wagtail takes insect prey from the air, ground, and tree. A species with narrow ecological requirements is obviously threatened if the habitat changes. The versatile and aggressive Willie Wagtail, by contrast, is able to linger in degraded habitats and be one of the first to recolonize when a habitat is restored.

Table 1 relates 108 species of forest and woodland birds to the four major habitats in terms of presence/absence and abundance. The data is based on considerable field work prior to 1960 when alienation of these forests had commenced. In the tall forest habitat prior to this 21 species were common, 25 present in moderate numbers, whilst 15 were rare, and 4 very rare. For the heathland and associated sandstone habitat the figures were: 9, 15, 23, and nil. In the Cumberland Plains woodlands there were 20 common species, 31 were present in moderate numbers, 20 were rare, and 2 very rare. Figures for the rainforest were: 9, 14, 14, and nil.

Eighteen and 14 were limited to the woodland and rainforest habitats, and five to the heathland. None occurred only in the tall forest. Thirty-six species occurred in only one habitat, and 13 in two.

Where a species has become conspicuously rarer in the last 50 years in the County of Cumberland as a whole this is indicated by an "r" in its formerly preferred habitat; where it has to all intents and purposes been eliminated this is indicated by an "e". Eleven and eight species fall into these respective categories although there are doubtless more of the former. Most belonged to the plains woodland group: they were not common and their area of habitat was limited. The status of these species outside of the County merits investigation because their inland habitat has been changed by over-grazing.

An effort was made in the previous sections to discern how birds respond to changed (i.e., degraded), as compared to eliminated habitat. It was found that a few adaptable species like the Willie Wagtail were able to do so fairly effectively, at least for some time. Table 1 potentially throws some light on this subject. Only one-third (34) of the 108 species occur in three or more of the four habitats, i.e., are plastic in habitat use. These, of course, are natural not degraded habitats.

Documentation and analysis of the habitat factor in bird distribution is only the first step in trying to explain numerical changes. It

hardly explains all. One group of birds that particularly concerns this writer are the ground-feeding Jacky Winter, Hooded Robin, Red-capped Robin, Speckled Warbler, and Whiteface.

A recent article in *Wingspan* commented on the loss of the first three from the outskirts of Melbourne, and David Paton (pers. comm.) states that this also applies near Adelaide. The reasons are not obvious.

The loss of Bluewrens from most Sydney suburbs is doubtless due to clearing of thickets and blackberries, the prevalence of cats and Currawongs, and possibly the use of insecticides. The species remains common in bushland areas. Variegated Wrens, confined to native bush, are as abundant as they ever were. The suppression of finch numbers on the Cumberland Plain is obviously due to a combination of habitat change (even though abundant grasses remain) and trapping. Note the differing abilities of marsh species to respond to change. Chats must have samphire; Reed Warblers and grassbirds are specialized for reedbed but they can survive in degraded reedbed without open water; Cisticolas are adaptable habitat-generalists and thrive in weed thickets and scrub.

BIRD SPECIES THAT HAVE BECOME COMMON IN THE SYDNEY AREA

This subject, as noted in the Introduction, has recently been explored by Alan Morris, New South Wales National Parks and Wildlife Service. My interpretation of the changes is as follows:

Parrots

Fifty years ago the White Cockatoo was limited to a few pairs in the Royal National Park. It is now widespread and abundant, with individuals even being frequently seen flying high over the city. Pairs have bred in suburban trees at Bankstown, and elsewhere. Increase stems from the provision of food by householders, feeding at picnic areas in the National Parks, and adaptation to suburbia. The Galah, common in dryer areas inland has, in later years, formed resident and semi-wandering pairs in inner suburbs. The two Corella species that in the 1940s formed small breeding groups on the Riverstone meat property (believed to have originated as aviary escapees) now occur as feeding groups in picnic areas of the Lane Cove Park, and elsewhere. The Eastern Rosella, with some shrinkage of range, remains common along

the Hawkesbury; the more arboreal Crimson Rosella has become more urbanized, accepting food from feeding trays.

The Rainbow Lorikeet was a rare bird near Sydney in the 1940s, being recorded only coincident with exceptional flowers of the eucalypts. It was well-known in the early days of settlement, and its numbers may long have been depressed by the cage-bird industry. The feeding of sweetened bread to visiting parties was initiated, it is believed, by a householder at Lindfield in the 1960s. Today, being fed by householders everywhere, it is one of Sydney's commonest birds, with pairs and groups attending not only houses but the tops of high-rise buildings at Kirribilli and McMahons Point, and commuting freely across the harbour between Greenwich and Balmain. Patches of natural vegetation and tall trees in the suburbs are used for nesting.

Honeyeaters

The Noisy Miner is now very common in the suburbs where it feeds on the nectar of trees in parks, and takes scraps from the ground; in between retaining its natural niche as a foliage gleaner. Social, noisy, and aggressive, it drives away native birds. The Red Wattlebird has also become common in gardens on the North Shore (especially), taking nectar from garden trees even in built-up areas, and gleaning for insects from various substrates. It is the main nest-host of the Koel Cuckoo.

Currawong, Magpie, Kookaburra, Grey Butcherbird

These four species are thoroughly urbanized. Severally, but especially the Currawong and Butcherbird, they are a major factor in the suppression of small birds in urban areas. Currawongs forage for nestlings by hopping along branches, systematically peering to either side and below, as do nest-predators elsewhere like the Blue Jay in North America. All four breed in suburban parks. Numbers of the last three have probably remained stable since the 1930s but Currawong numbers have increased many-fold and they have become resident.

Cuckoos

The Koel and Channelbill Cuckoos, dietary fruit (especially fig) specialists, have increased significantly over the 140 years, thanks to an excess of summer food in park trees and increased abundance of their nest hosts, the Red Wattlebird and Pied Currawong.

Willie Wagtail and Peewee

These two adaptable species are urbanized and widespread, though population levels remain fairly stable. The former nests in built-up areas like Blues Point, North Sydney, and even visits Circular Quay to sample flies amongst the street pigeons and gulls.

White Ibis

From being exclusively a water-bird with inland breeding range, this ibis is now a city park dweller, competing with the pigeons and gulls for scraps and, aided by its long legs and neck, lifting food bags from garbage containers. They now nest in Hyde Park and the Botanic Gardens.

Common Myna

In the 1930s this species was limited to a few dozen individuals inhabiting the immediate vicinity of the Cricket Ground and Showground in the inner city. A population explosion beginning in the late 1940s has led to this being the dominant species of settled areas west to the Hawkesbury River and beyond. It arrived from the densely settled cities of India already pre-adapted to successful life in urban habitats.

In summary, whilst most native bird species have retreated in the face of habitat loss and urbanization, a few larger and more aggressive species have maintained original numbers, and several (including introduced species) have multiplied numerically. Success of the last-named can generally be linked to food provided by man along with habitat changes that suit them.

DISCUSSION AND REVIEW

Over the last 50 years there has been a marked additional loss of prime bird habitat in the County of Cumberland and, with this, the virtual elimination of a number of species. The Cumberland Plains woodlands supported a unique combination of species not, as far as I know, duplicated in the State. Possibly comparable habitats in the Hunter Valley were eliminated earlier. The former North Shore tall forest habitat can be duplicated elsewhere. Saltmarshes remain at Towra Point and on the Hunter but additional losses of this habitat would be serious. Freshwater marsh habitat on the east coast has been severely reduced.

I have developed this account in terms of prime areas of habitat as I knew them in the 1930s and 1940s. These were acknowledged

by fellow ornithologists to be amongst the best, if not the best, examples of these bird communities known. It is self-evident that a review such as the present can only deal in generalities: there is a need for a modern quantitative and systematic assessment of contemporary bird habitats. There is also a need for a systematic assessment of the response of bird species to different kinds of change. And, ultimately, we can only predict responses, and initiate meaningful conservation measures by studies of the ecological needs and biology of species. What are their thresholds of tolerance; what territorial sizes are needed; what is a minimum breeding nucleus?

Ultimately, the most insidious threats may come from outside the system, degrading it even though it seems to be intact. I shudder to think of what could have happened to the creek-clinging temperate rainforest habitats and the creek-edge biological systems (of which the Lyrebirds and Scrubwrens are an integral part) had the proposed housing development at Helensburgh at the head of the watershed been allowed to go ahead. Urban runoff contains phosphorous-rich nutrients, herbicides, insecticides, and other chemicals. This would have affected the downstream life support systems, as well as the Hacking River used so extensively by weekend picnickers. Lyrebirds and the rainforest specialist bird species (Table 1) would have been adversely affected. Yet to the average person the habitat would have seemed intact.

(We Australians have, of course, been squandering our landscape for a century. In 1952 the Australian Museum organized a collecting expedition to Central Australia. On the basis of the 1897 Horn Expedition Report we expected to encounter Bilbies, Nail-tail and Hare Wallabies, Marsupial Moles, rodents of several kinds, Princess Parrakeets, and Black-banded Whitefaces. The only Bilby we saw was a captive one; the only other of the above expectations achieved was trapping small *Pseudomys* mice, an *Antechinus*, and an Orange-backed Bandicoot (now called the Golden Bandicoot, and the last-named ever to have been taken; fifty years of habitat degradation, overstocking, feral rabbits and cats, had taken their toll.)

The deleterious effect of Man on birds and wildlife is a world-wide problem. Recent surveys have shown that 40 species of European birds are on the decline partly due, apparently, to changed agricultural practices that no

longer allow land to lie fallow. A recent U.S. National Biological Service report (Noss *et al.* 1995) finds that many major vegetation types and aquatic systems have undergone losses exceeding 90% of their distributions since European settlement. Indeed, habitat loss is one of the major causes of a worldwide decline in biodiversity (IUCN/UNEP/WWF 1991; Rolstad 1991): frequently the process starts with habitat fragmentation, to be followed sooner or later by the degradation and eventual loss of the fragments themselves (Hinsley *et al.* 1995).

In this paper I have not endeavoured to explore the effects of habitat fragmentation on bird communities. This is a problem worldwide (Robbins *et al.* 1989; Merriam and Wagner 1992). Studies in North America provide graphic examples of how fragmentation makes breeding birds vulnerable to nest predators like jays, crows, raccoons and squirrels; and host-parasites like cowbirds: losses may equal 90% of nests (Wilcove *et al.* 1986). For the Sydney equivalent to jays and raccoons read Currawongs and domestic cats.

Every Sydney suburb has a town park. Most are small and lack native plant species. What is the minimum size for a reserve or National Park? This subject is also being explored on a world scale (e.g., Shafer 1995). It is immediately relevant to our maintaining, and developing, small reserves around Sydney. The answer is that the size of the reserve needed depends on the species. Some (like the Yellow Thornbill) can apparently persist in a small area; others (like hawks) need a huge expanse. Ultimately, however, the critical thing is to maintain a balanced ecosystem. Here the quote from Aldo Leopold (1953) is relevant: "to keep every cog and wheel is the first precaution in intelligent tinkering". The existence of large National Parks to the north and south of Sydney, even though they contain only a subset of habitats, is excellent. The minimum size question, and ultimate objectives, must be considered by any authority contemplating a reserve.

THE FUTURE OF SYDNEY BIRDS

Intense and unrelenting pressure for development with continued loss of habitat is inevitable. This being so, it becomes critical not to needlessly squander habitat and natural resources and to make restoration a major objective. Happily our intelligent and well-educated population has, and is, rising to such expectations. I am indeed encouraged by the reserves that have been created and on the

continued insistence on demanding an environmental impact statement as a pre-condition to development.

But the major tasks lie ahead. Complete habitat surveys must be initiated with the objective of understanding major ecosystems and how they operate. Note here the major inter-Departmental studies on the ecology of settled landscapes undertaken overseas (Riley and Mohr 1994). I note here with horror suggested plans that the NSW National Parks Service close its research branch and contract out studies. Contracted-out studies are always short-term, limited by funds, and lack the needed long-term continuity and commitment.

Data on the basic biology of our bird species is limited. In writing accounts there is far too much quoting from the old volumes like those of A. J. North. These present too rosy a picture: much of the information is not even relevant in these changed times. And there is a critical need for the publication of research results: too many fine studies are tucked away and lost in theses in university libraries.

Recent Australian writers, including Recher (1991) and Reed (1991) have stressed the critical need for research as a basis for conservation. Recently a leading overseas journal (Coulson and Crockford 1995) devoted 35 independent papers to exploring the opportunities and role of scientific research in conservation. Let us ever increasingly involve and fund our outstanding scientific community in these matters.

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APPENDIX 1

Scientific names of bird species discussed in text Order as per Christidis and Boles (1994)

- Anatidae — Musk Duck *Biziura lobata*; Black Swan *Cygnus stratus*; Wood Duck *Chenonetta jubata*; Black Duck *Anas superciliosa*; Shoveller *Anas rhynchos*; Grey Teal *Anas gracilis*; Chestnut Teal *Anas castanea*; White-eyed Duck, Hardhead *Aythya australis*.
- Podicipedidae — Australasian Grebe *Tachybaptus novaehollandiae*; Hoary-headed Grebe *Poliocephalus poliocephalus*.
- Phalacrocoracidae — Little Pied Cormorant *Phalacrocorax melanoleucus*; Little Black Cormorant *P. sulcirostris*; Great Cormorant *P. carbo*.
- Ardeidae — White-faced Heron *Egretta novaehollandiae*; Little Egret *E. garzetta*; White-necked Heron *Ardea pacifica*; Great Egret *A. alba*; Intermediate Egret *A. intermedia*; Cattle Egret *A. ibis*; Nankeen Night Heron *Nycticorax caledonicus*; Little Bittern *Ixobrychus minutus*; Black Bittern *I. flavicollis*; Australasian Bittern *Botaurus poiciloptilus*; Mangrove Heron *Butorides striata*.
- Threskiornithidae — White Ibis *Threskiornis molucca*; Straw-necked Ibis *T. spinicollis*; Royal Spoonbill *Platalea regia*; Yellow-billed Spoonbill *P. flavipes*.
- Accipitridae — Black-shouldered Kite *Elanus axillaris*; Brown Goshawk *Accipiter fasciatus*; Brown Falcon *Falco berigora*; Little Falcon (Hobby) *F. longipennis*; Nankeen Kestrel *F. cenchroides*.
- Rallidae — Buff-banded Rail *Gallirallus philippensis*; Baillon's Crake *Porzana pusilla*; Purple Swamphen *Porphyrio porphyrio*; Dusky Moorhen *Gallinula tenebrosa*; Eurasian Coot *Fulica atra*.
- Turnicidae — Painted Button-quail *Turnix varia*.
- Scolopacidae — Latham's Snipe *Gallinago hardwickii*; Sharp-tailed Sandpiper *Calidris acuminata*.
- Burhinidae — Bush Stone-curlew *Burhinus grallarius*.
- Recurvirostridae — White-hooded Black-winged Stilt *Himantopus himantopus*.
- Charadriidae — Golden Plover *Pluvialis fulva*; Red-capped Plover *Charadrius ruficapillus*; Black-fronted Dotterel *Elseornis melanops*; Spurwinged Plover (Masked Lapwing) *Vanellus miles*.
- Laridae — Silver Gull *Larus novaehollandiae*; Crested Tern *Sterna bergii*; Common Tern *S. hirundo*; Little Tern *S. albigrons*.
- Columbidae — Spotted Turtle-dove *Streptopelia chinensis*; Brown Pigeon (Cuckoo-dove) *Macropygia amboinensis*; Emerald Dove *Chalcophaps indica*; Wonga Pigeon *Leurosarcia melanoleuca*; Topknot Pigeon *Lopholaimus antarcticus*.
- Cacatuidae — Galah *Cacatua roseicapilla*; Long-billed Corella *C. tenuirostris*; Little Corella *C. sanguinea*; Sulphur-crested Cockatoo *C. galerita*.
- Psittacidae — Rainbow Lorikeet *Trichoglossus haematodus*; Princess Parrot *Polytelis alexandrae*; Crimson Rosella *Platycercus elegans*; Eastern Rosella *P. eximius*.
- Cuculidae — Pallid Cuckoo *Cuculus pallidus*; Brush Cuckoo *Cacomantis variolosus*; Fan-tailed Cuckoo *C. flabelliformis*; Black-eared Cuckoo *Chrysococcyx osculans*; Horsfield's Bronze-cuckoo *C. basalis*; Shining Bronze-cuckoo *C. lucidus*; Koel *Eudynamis scolopacea*; Channel-billed Cuckoo *Scythrops novaehollandiae*.
- Strigidae — Boobook Owl *Ninox novaeseelandiae*.
- Podargidae — Tawny Frogmouth *Podargus strigoides*.
- Alcedinidae — Azure Kingfisher *Alcedo azurea*.
- Halcyonidae — Laughing Kookaburra *Dacelo novaeguineae*; Sacred Kingfisher *Todiramphus sanctus*.
- Menuridae — Superb Lyrebird *Menura novaehollandiae*.
- Climacteridae — White-throated Treecreeper *Cormobates leucophaeus*; Brown Treecreeper *Climacteris picumnus*.
- Maluridae — Bluewren (Superb Fairy-wren) *Malurus cyaneus*; Variegated Wren *M. lamberti*; Southern Emu-wren *Stipiturus malachurus*.
- Pardalotidae — Spotted Pardalote *Pardalotus punctatus*; Striated Pardalote *P. striatus*.
- Acanthizinae — Pilotbird *Pycnoptilus floccosus*; Rockwarbler *Origma solitaria*; Yellow-throated Scrubwren *Sericornis citreogularis*; White-browed Scrubwren *S. frontalis*; Large-billed Scrubwren *S. magnirostris*; Chestnut-rumped Heathwren *Hylacola pyrrhopygia*; Speckled Warbler *Chthonicola sagittata*; Weebill *Sericornis brevirostris*; Brown Warbler *Gerygone mouki*; White-throated Warbler *G. olivacea*; Brown Thornbill *Acanthiza pusilla*; Buff-rumped Thornbill *A. reguloides*; Yellow Thornbill *A. nana*; Striated Thornbill *A. lineata*; Yellow-rumped Thornbill *A. chrysorrhoa*; Southern Whiteface *Aphelocephala leucopsis*.
- Meliphagidae — Red Wattlebird *Anthochaera carunculata*; Little Wattlebird *A. chrysoptera*; Leatherhead (Noisy Friarbird) *Philemon corniculatus*; Regent Honeyeater *Xanthomyza phrygia*; Bell Miner *Manorina melanophrys*; Noisy Miner *M. melanocephala*; Lewin's Honeyeater *Meliphaga lewinii*; Yellow-faced Honeyeater *Lichenostomus chrysops*; Yellow-tufted Honeyeater *L. melanops*; Fuscous Honeyeater *L. fuscus*; White-

Appendix 1 — *continued*
 Meliphagidae — *continued*

Honeyeater *L. melanops*; Fuscous Honeyeater *L. fuscus*; White-plumed Honeyeater *L. penicillatus*; Black-chinned Honeyeater *Melithreptus gularis*; White-naped Honeyeater *M. lunatus*; Brown Honeyeater *Lichmera indistincta*; Painted Honeyeater *Grantiella picta*; Eastern Spinebill *Acanthorhynchus tenuirostris*; Scarlet Honeyeater *Myzomela sanguinolenta*.

Epthianurinae — White-fronted Chat *Epthianura albifrons*.

Petroicidae — Jacky Winter *Microeca fascians*; Red-capped Robin *Petroica goodenovii*; Rose Robin *P. rosea*; Hooded Robin *Melanodryas cucullata*; Eastern Yellow Robin *Eopsaltria australis*.

Cinclosomatidae — Eastern Whipbird *Psophodes olivaceus*.

Neosittidae — Varied Sittella *Daphoenositta chrysoptera*.

Pachycephalidae — Crested Shrike-tit *Falcunculus frontatus*; Golden Whistler *Pachycephala pectoralis*; Rufous Whistler *P. rufiventris*; Grey Shrike-thrush *Colluricincla harmonica*.

Dicruridae: Monarchinae — Black-faced Monarch *Monarcha melanopsis*; Leaden Flycatcher *Myiagra rubecula*; Restless Flycatcher *Myiagra inquieta*.

Grallinae — Peewee (Magpie-lark) *Grallina cyanoleuca*.

Rhipidurinae — Rufous Fantail *Rhipidura rufifrons*; Grey Fantail *R. fuliginosa*; Willie Wagtail *R. leucophrys*.

Campephagidae — Black-faced Cuckoo-shrike *Coracina novaehollandiae*; Little (White-breasted) Cuckoo-shrike *C. papuensis*; Cicadabird *C. tenuirostris*; White-winged Triller *Lalage sueurii*.

Oriolidae — Olive-backed Oriole *Oriolus sagittatus*; Figbird *Shecotheres viridis*.

Artamidae — Masked Woodswallow *Artamus personatus*; White-browed Woodswallow *A. superciliosus*; Dusky Woodswallow *A. cyanopterus*.

Cracticidae — Grey Butcherbird *Cracticus torquatus*; Australian Magpie *Gymnorhina tibicen*; Pied Currwaong *Strepera graculina*.

Corvidae — Australian Raven *Corvus coronoides*.

Ptilonorhynchidae — Spotted Catbird *Ailuroedus melanotis*; Satin Bowerbird *Ptilonorhynchus violaceus*.

Alaudidae — Skylark *Alauda arvensis*.

Motacillidae — Richard's Pipit *Anthus novaeseelandiae*.

Passeridae — House Sparrow *Passer domesticus*; Zebra Finch *Taeniopygia guttata*; Double-barred Finch *T. bichenovii*; Red-browed Finch *Neochmia temporalis*; Diamond Firetail *Stagonopleura guttata*; Beautiful Firetail *S. bella*.

Fringillidae — European Goldfinch *Carduelis carduelis*.

Hirundinidae — Welcome Swallow *Hirundo neoxena*; Tree Martin *H. nigricans*; Fairy Martin *H. ariel*.

Pycnonotidae — Red-whiskered Bulbul *Pycnonotus jocosus*.

Sylviidae — Clamorous Reed-Warbler *Acrocephalus stentoreus*; Little Grassbird *Megalurus grammurus*; Golden-headed Cisticola *Cisticola exilis*.

Zosteropidae — Silvereye *Zosterops lateralis*.

Muscicapidae Turdinae — Bassian Thrush *Zoothera lunulata*; European Blackbird *Turdus merula*.

Sturnidae — Common Starling *Sturnus vulgaris*; Common Myna *Acridotheres tristis*.

APPENDIX 2

"Waste" terrain plants of the Cooks River

This "waste" terrain is largely vegetated by introduced plants such as: castor oil plant (*Ricinus communis*), South African boxthorn (*Lycium ferocissimum*), lantana (*Lantana camara*), Kikuyu (*Pennisetum*), fleabane (*Conyza albida*), green

poison berry (*Cestrum parqui*), fennel (*Foeniculum vulgare*), purple top (*Verbena bonariensis*), "fireweed" (*Senecio madagascariensis*), common centaury (*Centaureum erythraea*), the vine (*Hydrocotyle bonariensis*), Paddy's lucern (*Sida rhombifolia*).